

REMARKS

Claims 5-8, 16-17, 20-21, 23-26 and 32-33 remain pending. Claims 5, 7, 8 and 33 are currently amended. Applicants respectfully request reexamination and reconsideration of the application in light of the amendments and the following remarks.

Section 101 Rejection

Claims 5-8, 16-17, 20-21, 23-26 and 32-33 stand rejected under 35 U.S.C. 101 for disclosing an invention that is inoperative and therefore lacks utility. Applicants respectfully traverse this rejection.

Immediately after teaching that “cooling system 214 can circulate any type of liquid coolant and/or gas coolant”, Applicants disclose example types of coolant: “ethylene glycol, liquefied nitrogen, fluorocarbons, FLORINERT, FREON, and a combination of FREON and a nonfreezing liquid.” Page 11, paragraph [0045] of the original application as filed. FLORINERT is a least one of the examples given that has the readily known property of a high dielectric strength so as not to conduct electricity between the contacts on or connected to the semiconductor die being cooled. It is well known by those skilled in the art that either such a non-conducting coolant should be used or well known electrical insulation means should be provided over exposed connectors and/or contact pads to prevent electrical shorting. Accordingly, Applicants respectfully request that this rejection be removed.

Section 103 Rejection

Claims 5-8, 16 and 23-24, and 32-33 stand rejected under 35 U.S.C. 103(a) as being unpatentable over Smith et al. (U.S. Patent No. 6,184,065, hereafter “Smith”) in view of Patel et al. (U.S. Patent No. 6,550,263, hereafter “Patel”). Applicants respectfully traverse this rejection.

Patel teaches the use of a spray cooling system to cool semiconductor devices (i.e. “chips”). Col. 1, lines 7-11. As shown in Fig. 2, “the spray mechanism 105 is configured to spray cooling fluid 117 onto the one or more chips 101, which heat and vaporize some, or more preferably all, of the cooling fluid.” Col. 5, lines 30-32. “Preferably, the spray mechanism 105 is an incremental sprayer configured to eject an incremental amount of the cooling fluid on the chips.” Col. 5, lines 36-38. Patel does not teach or suggest a continuous fluid flow, or immersing the chips in fluid. In fact, Patel teaches away from the present invention by indicating that the sprayers are preferably adjusted to avoid having the chips become immersed. Patel is concerned with cooling a top surface of the chips facing the sprayers and does not teach or suggest that a bottom surface having active components can be effectively cooled.

In contrast to Patel, the present invention as defined by the present claims is directed to a cooling assembly which provides continuous fluid flow around an entire semiconductor die. Page 2, paragraph [0004] of the present application as originally filed. This arrangement is particularly advantageous when a die surface having active components in need of cooling is facing down toward a supporting substrate rather than toward a cooling fluid inlet. Page 3, paragraph [0007].

With regard to claims 5-7, Patel, taken alone or in combination, does not teach or suggest “at least one coolant port that allows a coolant to continuously enter the cavity and directly cool the active electronic components of each die.”

With regard to claim 8, Patel does not teach or suggest “when the coolant circulates in the cavity the coolant directly cools each surface of each die”.

With regard to claim 16, Patel does not teach or suggest a package which “further comprises a bottom substrate on one side of the cavity, wherein each die with active electronic components is connected to the bottom substrate by the compliant interconnects, and wherein the active electronic components face the bottom substrate and contact coolant surrounding the compliant interconnects within the cavity.”

With regard to claim 23, Patel does not teach or suggest that “the coolant circulates within the package and directly contacts all surfaces of each die to directly cool active electronic components during their operation.”

With regard to claim 24, Patel does not teach or suggest that “each die is immersed in the coolant.”

With regard to claim 32, Patel does not teach or suggest “at least one coolant port that allows a coolant to continuously enter the cavity and directly cool the active electronic components of each die.”

With regard to claim 33, Patel does not teach or suggest “at least one die with active electronic components non-rigidly mounted on second ends of the compliant interconnects on a same surface of the at least one die having the active electronic components”.

For at least the foregoing reasons, claims 5-8, 16, 23-24 and 32-33 are believed allowable as non-obvious over Smith in view of Patel.

Claims 7 and 8 have been amended to correct typographical errors.

Allowable Claims

Claims 17, 20-21 and 25-26 are indicated by the Office Action as allowed.

Conclusion

In light of the above amendments and remarks, claims 5-8, 16-17, 20-21, 23-26 and 32-33 are now all believed to be in condition for allowance. Accordingly, reconsideration and allowance of these claims is respectfully requested.

No fee is believed due with this response. Should a fee be due, the Commissioner is hereby authorized to charge the fee to Deposit Account No. 50-0285 (order no. P148-US).

Respectfully submitted,

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By: Douglas C. Limbach
Douglas C. Limbach
Reg. No. 35,249

FormFactor Inc.
7005 Southfront Rd.
Livermore, CA 94551
Telephone: (925) 290-4000
Facsimile: (925) 290-4119